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Application Number	10/622,105
Filing Date	07/17/2003
First Named Inventor	Parminder S. Sangha
Group Art Unit	2834
Examiner Name	
Attorney Docket Number	248-00284

TRANSMITTAL FORM

(to be used for all correspondence after initial filing)

Total Number of pages in this Submission

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Remarks

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT

Firm Or Individual Name	JOSEPH J. JOCHMAN (Reg. No. 25,058) ANDRUS, SCEALES, STARKE & SAWALL, LLP 100 East Wisconsin Avenue, Suite 1100, Milwaukee, WI 53202
Signature	
Date	September 9, 2003

CERTIFICATE OF MAILING

I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail in an envelope addressed to: Assistant Commissioner for Patents, Washington, DC 20231 on this date:

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

PATENT

Application Of:)
PARMINDER S. SANGHA)
Application No.: 10/622,105)
Filed: 07/17/2003)
Group Art Unit: 2834)
Examiner:)
HEATING SYSTEM)

TRANSMISSION OF PRIORITY DOCUMENT

COMMISSIONER FOR PATENTS
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Sir:

Enclosed is a certified copy of the priority document identified in the formal papers of this application as filed.

The claim for priority made in the formal papers is reiterated.

Acknowledgement of the receipt of this certified copy in the next Patent Office correspondence is respectfully requested.

Respectfully submitted,

ANDRUS, SCEALES, STARKE & SAWALL, LLP

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INVESTOR IN PEOPLE

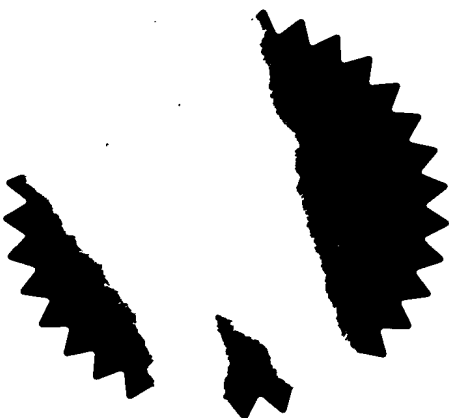
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NP10 8QQ

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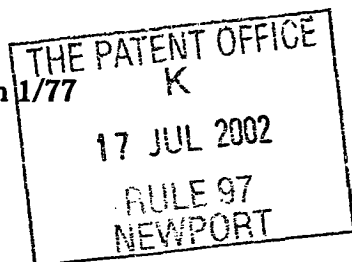
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Dated

24 July 2003





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P01/7700 0.00-0216713.8

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The Patent Office

Cardiff Road
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1. Your reference	R071502PGB		
2. Patent application number (The Patent Office will fill in this part)	0216713.8		
3. Full name, address and postcode of the or of each applicant (underline all surnames)	Lucas Industries Limited Stratford Road, Solihull West Midlands B90 4LA England		
Patents ADP number (if you know it)			
If the applicant is a corporate body, give the country/state of its incorporation	England		
4. Title of the invention	HEATING SYSTEM		
5. Name of your agent (if you have one)	Marks & Clerk Alpha Tower Suffolk Street Queensway Birmingham B1 1TT England		
"Address for service" in the United Kingdom to which all correspondence should be sent (including the postcode)			
Patents ADP number (if you know it)	18002 ✓		
6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and (if you know it) the or each application number	Country	Priority application number (if you know it)	Date of filing (day / month / year)
7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application	Number of earlier application	Date of filing (day / month / year)	
8. Is a statement of inventorship and of right to grant of a patent required in support of this request? (Answer 'Yes' if: a) any applicant named in part 3 is not an inventor, or b) there is an inventor who is not named as an applicant, or c) any named applicant is a corporate body. See note (d))	Yes		

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Description 6 ✓

Claim(s)

Abstract

Drawing(s) 1 + 1 ✓

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Priority documents

Translations of priority documents

Statement of inventorship and right to grant of a patent (Patents Form 7/77)

Request for preliminary examination and search (Patents Form 9/77)

Request for substantive examination (Patents Form 10/77)

Any other documents (please specify)

11.

I/We request the grant of a patent on the basis of this application.

Signature

Date

16 JULY 2002

12. Name and daytime telephone number of person to contact in the United Kingdom

Joanne S POPLÉ 0121 643 5881

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HEATING SYSTEM

The present invention relates to a heating system and particularly, but not exclusively, to a system for heating fluid used for cooling and/or lubricating a motor or the like. The invention finds particular application in heating the hydraulic fluid used in electro-hydraulic actuators to cool and/or lubricate the motor which drives the hydraulic pump.

Aircraft often employ electro-hydraulic actuators as control systems for the primary flight control surfaces of the aircraft, for example the ailerons, spoilers, elevators and rudder. Such electro-hydraulic actuators generally include an actuator for moving the flight control surfaces under the control of an hydraulic pump. Conventionally, the hydraulic pump is driven by an electric motor to which it is directly mounted.

It is known to use the hydraulic fluid from the pump as a lubricant and coolant for the electric motor. Specifically, the hydraulic fluid from the pump is allowed to flow into the motor and through the air gap between the rotor and the stator of the motor. The fluid exits the motor at the end remote from the hydraulic pump and is directed back into the hydraulic system. The fluid flowing through the motor lubricates the motor bearings and provides a cooling effect on the motor itself.

Typically, the hydraulic fluid which is used is highly corrosive, for example Type 4 phosphate ester. It is therefore necessary to isolate the stator windings from the fluid. A sleeve is therefore provided in the air gap which lines the stator bore and isolates the coil windings from the hydraulic fluid.

The motor is required to operate over a temperature range of between approximately -55°C and 120°C. As the temperature of the hydraulic fluid decreases, its viscosity increases such that at the lower end of the operating temperature range, the viscosity of the hydraulic fluid can impede or prevent the motor from starting. Clearly, this can be a problem where the electro-hydraulic actuator is used on aircraft intended to operate in regions having an extremely cold climate and can be highly dangerous if the motor fails to start whilst the aircraft is in flight at an altitude where the temperature is extremely low.

US 4, 922, 119 discloses a starting system for an aircraft propulsion engine. An electric motor is mounted within a case which contains hydraulic fluid used by first and second hydraulic units as part of a constant speed drive transmission. The electric motor provides some heating for the hydraulic fluid but this heating exists only after power up of the motor and is therefore of no assistance in starting the motor itself.

It would be advantageous to provide a method and/or apparatus which addresses the problem of starting the electric motor at very low temperatures.

According to one aspect of the present invention, therefore, there is provided an electric motor arranged for passing therethrough a supply of fluid for cooling and/or lubricating said motor, the motor being provided with heating means for heating the fluid when the fluid enters the motor.

Advantageously, the motor is arranged such that the fluid flows through an annular gap between the rotor and the stator of the motor.

Conveniently, means are provided for isolating the stator windings from the fluid.

Preferably, the heating means is arranged, in use, to raise the temperature of the fluid above -50°C . More preferably, the heating means is arranged, in use, to raise the temperature of the fluid to a value no less than -40°C .

5

Preferably a thermostatic switch is used in association with the heating means.

Advantageously, the heating means is arranged such that it is not in contact with the fluid.

10

Preferably, the heating means comprises an annular heating element.

The heating element may be mounted to the motor radially outwardly or behind the motor bearings.

15

Preferably, the heating element is mounted close to or adjacent to a region of the motor at which the fluid enters the motor. More preferably, the heating element is mounted to the bearing block of the motor.

20 The motor may be associated with an hydraulic pump and the fluid may comprise hydraulic fluid supplied by said hydraulic pump.

In one embodiment, the motor is used to drive an hydraulic pump forming part of an electro-hydraulic actuator.

25

The present invention will now be described, by way of example only, with reference to the accompanying drawing which illustrates a section through a preferred form of motor according to the invention.

Referring to the drawing, a motor according to the invention is shown generally at 10. The motor 10 comprises a rotor 12, rotatably mounted within a casing 14 of the motor, and a stator 16 including a plurality of windings 16a and a magnetic core 16b.

5

The rotor 12 is radially spaced from the stator within the housing 14 such that an annular gap 18 exists therebetween. The rotor 12 rotates within the housing 14 on bearings 20 which are mounted within a so-called bearing block 21.

10 In the illustrated embodiment, the motor is associated with an hydraulic pump (not shown) which is connected to the motor at one end E thereof and driven by the rotor 12. The hydraulic pump may be arranged to control an hydraulic actuator by means of the application of hydraulic fluid thereto.

15 In order to provide a cooling effect on the rotor 12 and stator 16 of the motor and to lubricate the bearings 20 within the bearing block 21, the hydraulic pump is arranged to provide a source of hydraulic fluid which is applied to, and flows through, a fluid path, illustrated by the arrows in the drawing, defined within the motor.

20

Specifically, the fluid flows into the bearing block 21 from the pump to provide lubrication for the bearings 20 and then through the annular gap 18 defined between the rotor 12 and the stator 16 of the motor. A drain hole (not shown) is provided in the casing 14 of the motor at a second end D thereof for recycling

25 back to the hydraulic pump or to the hydraulic system to which the pump is connected.

As described above, at temperatures below approximately -40°C , the viscosity of the hydraulic fluid becomes high enough to effect the operation of the motor. In

particular, the starting torque of the motor is insufficient to overcome the viscosity of the hydraulic fluid and, at temperatures below -40°C , it may become difficult or impossible to start the motor.

- 5 The present invention therefore provides heating means, in the form of an annular heating element 22, thermally coupled to the body of the motor. The heating element preferably comprises an electric heater but may conveniently comprise any suitable heating apparatus.
- 10 The heating element 22 is disposed radially outwardly of the bearing block 21 but in close proximity thereto. Preferably, the heating element is mounted directly to the bearing block 21, in good thermal contact therewith. The heating element 22 is physically and/or electrically isolated from the hydraulic fluid flowing through the bearing block 21, in order to reduce or substantially
- 15 eliminate the likelihood of fire.

Due to good thermal contact with the heating element 22, the main body of the motor, which is closely coupled to the pump, is heated. Thus, fluid within the pump also experiences a temperature rise, resulting in improved pump efficiency

20 at low temperatures.

The heating element 22 is arranged to raise the temperature of the hydraulic fluid by approximately 15°C , for example from -55°C to approximately -40°C . This relatively small increase in temperature is sufficient to reduce the viscosity of the

25 hydraulic fluid to a level at which it does not affect the operation of the motor.

Owing to the relatively small rise in temperature required, it is envisaged that the heating element 22 may have a power rating of approximately 100 watts. The heating element 22 may be provided with a thermostat which switches on the

heating element 22 at a temperature of between -40°C and -30°C . Heat from the heating element 22 is transmitted through the bearing block 21 and the bearings 20 to the hydraulic fluid so as to provide a good thermal contact therewith.

5

Since the hydraulic fluid is heated on entering the motor, only a relatively low power heating element is necessary and the arrangement avoids the need to heat all of the hydraulic fluid thereby increasing the efficiency of the apparatus.

10

It will be appreciated that the present invention provides a simple and effective solution to the problem of increased hydraulic fluid viscosity at very low temperatures. The heating element is simple and inexpensive to fit to existing motors and requires very little power.

